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GROWTH OF ZINC SELENIDE CRYSTALS BY PHYSICAL VAPOR TRANSPORT IN MICROGRAVITY

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General Status

In discussions with our CoTR and other interested MSFC personnel in January, 1994, it was decided to coordinate the efforts under this grant with those to be performed under Grant NAG8-842 "Research Support for CdTe Crystal Growth". This consolidation occurred due to Dr. Franz Rosenberger becoming the principal investigator of this grant. The goal of this coordinated research will be the growth of CdTe single crystals of high structural and compositional quality using the Effusive Ampoule Physical Vapor Transport method.

Therefore, the revised research tasks are:

a) Design and construction of a three-zone furnace. Though similar in dimensions to the furnace previously used for the growth of ZnSe, this new design is to provide for greater flexibility in the adjustment of temperature profiles, and ensure a longer lifetime of the heating element. In addition, the design should accommodate a low-power, high-temperature microscope for *in-situ* viewing of the crystal.
b) Determination of the most advantageous ampoule design for seeded growth. In particular, growth should proceed without contact between the crystal and side wall.
c) Crystal growth using a variety of seeds with orientations ranging from (100) to (511) to determine which interface orientation leads to lower twin and etch pit densities.
d) Characterization of the grown CdTe crystals, including:
   - etch pit densities by etching and optical microscopy,
   - precipitate density and physical structure by infrared microscopy,
   - twin boundary distributions by multi-direction sectioning.
e) Correlation between seed orientation, growth conditions and crystal quality.

Work Performed

The furnace has been designed and constructed. It consists of a custom-built continuously wound element with taps for three independently controlled heating zones. The element is wound from 5 gauge heating wire, which necessitates the use of step-down transformers. A 1/4" gap was provided between the 2 center turns in the middle zone to accommodate the front lens of the high-temperature microscope; see below. The heating element and thermal insulation has been placed in a water-cooled shell and mounted into a cage that moves the furnace, relative to the fixed ampoule, via a 25,000 steps/cm stepper motor.

The optical monitoring arrangement consists of a specially designed high-temperature end attached to the rack-and-pinion and the eyepiece of a commercial Gaertner telemicroscope. The silica/Inconel high-temperature end holds a 5 mm diameter, 10 mm f.l. silica lens that is positioned between two turns of the middle furnace zone. A relay lens (22 mm o.d., 40 mm f.l.) is placed between the eyepiece and front lens. The magnification of this high-temperature microscope is 10 or 14X depending on the eyepiece used.

The temperature profiling of the furnace with type S thermocouples was completed. Axial and azimutal temperature distributions were determined for anticipated growth conditions with a vacuum shroud, and with and without a dummy ampoule. With the vacuum shroud alone, temperature differences of one or two degrees were observed between thermocouple bead positions being directly over the heating wire or between two windings, respectively. These differences decreased to a few tenths of a degree within the dummy ampoule. In contrast to the older furnace, the microscope viewing ports did not induce any measurable deformation of the temperature profile.

The growth ampoule has been redesigned based on our previous crystal growth experience with CdTe and ZnSe. The changes that we have incorporated into our ampoule, schematically shown in Fig. 1, are:

1) The solid silica glass lightpipe extends up into the ampoule rather than ending at the bottom groundjoint. A similar design was used before and allowed us to grow both ZnSe and CdTe crystals without any ampoule wall contact.

2) The source chamber can be directly loaded, rather than requiring a separate vacuum transport step. This alleviates two undesirable features of our earlier approach: the temperature cycling before loading of the seed; and cracking of the ampoule on temperature cycling, that occurs when the presublimed source material thermally expands in the ampoule. Low fugacity impurities will still be retained in the source chamber, and high fugacity impurities will be preferentially removed through the effusion hole.

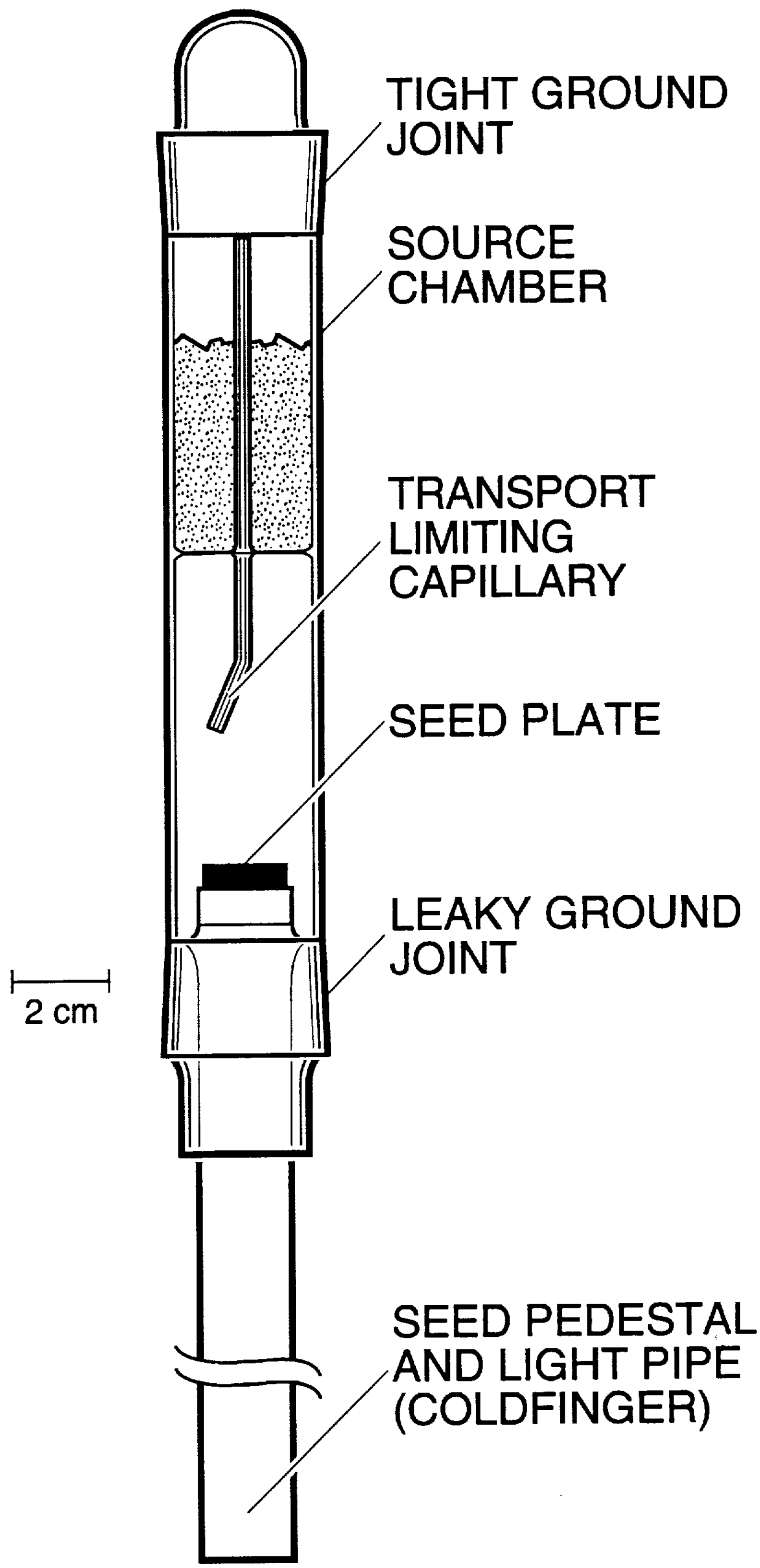

Fig. 1. Demountable ampoule for EAPVT.